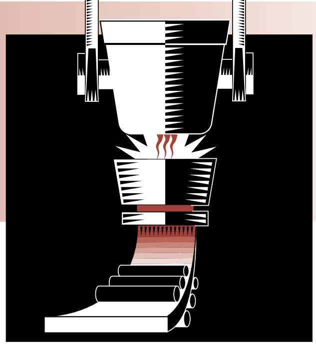
STEEL

Project Fact Sheet



Cold Work Embrittlement (CWE) of Interstitial-Free (IF) Steels

Benefits

- Enable steel producers to increase supply of medium-strength IF steel
- Enable parts manufacturers to reduce the occurrence of fracture during secondary deformation
- Establish ability for vehicle manufacturers to produce more reliable cars
- Enable positive environmental impact through weight reduction resulting from a better usage of medium-strength IF steel in the automotive industry

Applications

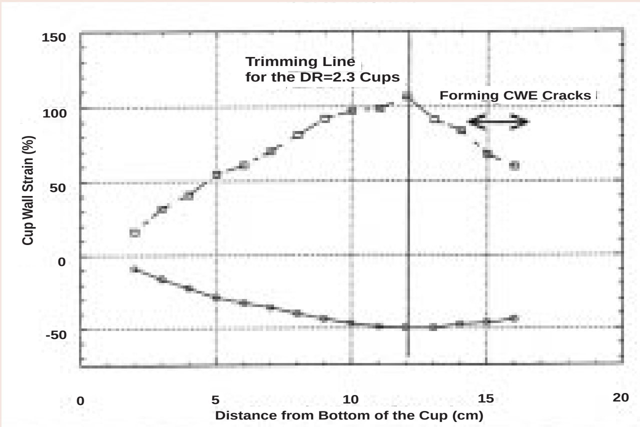
The research will provide information to improve the performance of IF steel grades in the production of steel parts.

Development of a reliable method to predict CWE failure in IF steels

Steel and parts manufacturers need to determine the sensitivity of IF steels to CWE in order to reduce the occurrence of fracture during secondary deformation and to ensure the in-service reliability of parts. Ultra-low carbon, interstitial free steel (ULC-IF) sheets are widely used in the automotive industry. The absence of solute interstitial elements in these steels leads to sensitivity to cold work embrittlement. This may lead to brittle fracture during secondary forming of deep-drawn parts or in-service failure. CWE may also affect fatigue performance.

A standard, reliable methodology for CWE testing needs to be developed. To be relevant to steel users, CWE measurements must be conducted using conditions that simulate those in-service. They should be representative of the fracture condition observed in formed parts and should establish the relationship between laboratory data and failures within real parts. To date, the most common approach appears to be measuring the ductile-to-brittle transition temperature (DBTT) by fracture of a deep-drawn cup using a plunger to open it. The transition temperature obtained with this test varies with the test conditions. A better understanding of the factors that affect the DBTT will help to determine more accurately the temperature at which brittle fracture may occur in more complex parts.

Chart of Strain Distribution



Strain distribution in a drawn cup with 2.3 draw ratio.

Project Description

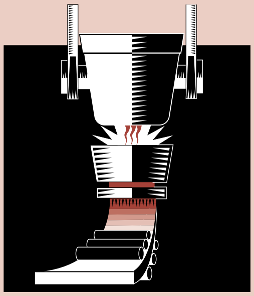
Goals: To develop a correlation between CWE laboratory test results and fracture in real parts used by industry. This project also aims to determine the relationship between steel CWE sensitivity, primary strain conditions and fatigue resistance.

A survey was carried out to select suitable candidate materials for this study and to document parts failure (part geometry, steel chemistry, strain level, and deformation mode). The cup draw expansion and bend tests were evaluated. Validation of the laboratory CWE tests was made with CWE failure in real parts. Seven commercial steels were selected to evaluate the effect of the steel chemistry and phosphorus segregation on CWE, and to study the influence of several test conditions on CWE. One steel was selected for fatigue tests to determine if a relationship can be established between fatigue in drawn parts and intergranular fracture by CWE in deformed parts and undeformed materials.

Project Start: February, 1998
Project Completion: First Quarter, 2001

Progress and Milestones

- Completion of two reports on a company and literature survey on CWE test methods (September, 1998).
- Development of a test procedure for the 150-mm cup/expansion test (September, 1998).
- Production and delivery of seven steels for the parametric study (April, 1999).
- Production and delivery of five steels for the fatigue study and for the fabrication of real parts (June, 1999).
- Fabrication of real parts using low and high sensitivity steels for impact testing in laboratory (July, 1999).
- Stamping of deep-drawn parts for production of pre-strained specimens for the fatigue study (August, 1999).
- Completion of the parametric study on the effect of strain, cup edge condition, specimen size, impact speed, steel chemistry, and sheet thickness (February, 2000).
- Completion of the impact tests on real parts (April, 2000).
- Dissemination of preliminary results at the Mechanical Working and Steel Processing Conference in Toronto (October, 2000).
- Draft report on correlation between laboratory test results and fracture in real parts (October, 2000).
- Final report on CWE study (March, 2001).
- Completion of fatigue tests on prestrained specimens (January, 2001).
- Final report on fatigue (March, 2001).
- Project status meetings held with participating companies (eight).



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